

Drawings

The objection to the drawings for using the identifier "Fig. 1" where only a single view was used has been addressed. The objection was resolved by deleting the "Fig. 1" identifier from the instant drawing.

Claims

The examiner kindly stated that original claims 2,4,6,8, 10 and 13 would be allowable if rewritten in independent form. Independent claim 1 has been amended to include all the limitations of original claims 2 and 8; claim 7 has been amended to include all the limitations of original claims 4 and 10; and claim 20 has been added to include all the limitations of original claims 6 and 13. Therefore amended claims 1 and 7 and new claim 20 are now believed to be in allowable form. In addition, applicants have amended and added other claims. Applicants believe these new and amended claims are in allowable form as well. All changes have support in the original disclosure and are briefly listed below:

Claims 2, 4, 5, 6, 8 10,12, 13 and 17 have been deleted.;

Claims 1,7,14, and 15 have been amended;

Claims 20-30 have been added.

Claim Rejections under 35 U.S.C. § 102

The examiner has rejected claims 1, 3, and 5 under 35 U.S.C. §102 as being anticipated by US 6,447,740 B1 (Caldwell et al.) As explained above, and recommended by the examiner, amended claim 1 now includes all the limitations of original claim 2 which examiner notes are not disclosed by Caldwell. Caldwell fails to teach or even suggest using chloric acid as the oxidizing agent. It is believed that, claim

1, as amended, distinguishes over Caldwell and is in allowable form in accordance with examiner's instructions.

Claim 3 is dependent on amended claim 1 and is therefore not anticipated for the same reasons given for claim 1.

Claim 5 has been deleted.

Claim Rejection under 35 U.S.C. § 103

The examiner has rejected claims 7,9,11,12 and 14-19 under 35 U.S.C. § 103 as being anticipated by Caldwell et al. Applicants submit that there is insufficient basis for regarding Applicant's claims as unpatentable over Caldwell, as suggested by examiner. Applicants supports their position by citing the substantial differences between Applicants amended claims and those disclosed by Caldwell.

Caldwell et al., discloses a process for the removal of contaminants such as mercury, SO<sub>2</sub>, NO, NO<sub>2</sub>, and H<sub>2</sub>S from flue gas streams. The Caldwell process comprises: contacting the flue gas stream with chlorine in a gaseous form, a liquid form, or as a chlorine water solution, at a temperature greater than 100°C and for a sufficient time to form an oxidized form of the contaminants. The oxidized stream is thereafter scrubbed with water, or water solution, of pH less than or equal to 7 and finally an alkali metal iodine solution is added to precipitate mercuric iodide from the water or water solution.

In regard to amended claim 7 and original claim 14 examiner suggests that "vaporizing an aqueous solution containing an oxidizing agent" or "vaporizing an oxidizing agent" would have been obvious to one of ordinary skill in the art in light of Caldwell. While the examiner is correct that Caldwell teaches the use of gaseous chlorine as an oxidizing agent, Caldwell also teaches the use of liquid chlorine and

chlorine water solutions as oxidizing agents which is exactly what the applicant's teach to avoid. See, Caldwell, col. 3, lines 11-13, col. 1, lines 55-56. Applicants specifically teach using only a vaporized oxidizing agent because it has been shown that vaporized oxidizing agents are much more effective than liquid or atomized oxidizing agents in removing Hg and NO from gas streams. (see, page 4 lines 5-9, pg. 11 lines 19-25, of the original specification. Tables 4 and 5 of the original specification clearly show the advantages of using a vaporized oxidizing agent. (see pgs 11-12 of the original specification) Table 4 shows that vaporized agents remove more NO from the gas stream than the atomized agents even when the vaporized agents are 20 times lower in concentration than their atomized cousins. Table 5 illustrates that vaporization dramatically improves the ability of the oxidizing agent to remove Hg from the gas stream. The vaporized agents removed similar amounts of Hg from a gas stream with about a five-times lower concentration as compared to the use of atomized agents. The importance of vaporization to the present invention is evident from applicant's abstract, specification and amended claims. See, pg. 3 lines 27-28, pg. 4 lines 5-10, pg 17, and claims 1,7,14 and 20 of the original application.

In addition, Caldwell never discloses or suggests how to vaporize an oxidizing agent. The present invention teaches how to create a vaporized oxidizing agent from oxidizing solutions. See, page 5, line 10-17 of the original specification and Claim 28. This vaporization step is especially important when the oxidizing agent is a solution at room temperature, such as chloric acid or a mixture of chloric acid and alkali metal chlorate.

Furthermore, amended claim 7 has been amended to include the limitations of claim 10 which are not disclosed by Caldwell as noted by the examiner on page 4,

(paragraph 7) of the first office action. Since all the limitations of original claim 10 have been incorporated in independent form in amended claim 7, applicants feel that claim 7 is now in compliance with examiners instructions and is now in allowable form.

Moreover, amended claim 14 and new 29 teach contacting the flue gas with an alkaline moiety after the oxidation process. See claims 14 and 29, and pg. 5 lines 3-5, pg. 5 line 30 through pg. 5 line 2 of the original application. Caldwell teaches away from the present invention by teaching scrubbing the flue gas with water or water solution of pH less than or equal to 7 which is exactly the opposite of what applicants teach. See, Caldwell col. 1 lines 61-67, col. 4 lines 19-25 and lines 35-40. For these reasons applicants submit that claims 14 and 29 distinguish over Caldwell and are now in allowable form.

Claim 9, which is dependent upon independent claim 7 is believed to distinguish over Caldwell for the same reasons as recited for claim 7 above.

Claim 11, which is also dependent upon independent claim 7 is believed to distinguish over Caldwell for the same reasons as recited for claim 7. In addition, claim 11 discloses that the presence of NO<sub>x</sub> enhances the capture of mercury using the present process. For support see, pg 5, lines 15-25 of the original specification. The examiner submits that Caldwell discloses that the presence NO<sub>x</sub> in the flue gas enhances the capture of mercury. While it is true that Caldwell teaches the conversion of metallic mercury to mercuric chloride in the presence of NO<sub>x</sub>, nowhere does Caldwell teach or even suggest that NO<sub>x</sub> in any way enhances the removal of metallic mercury from a flue gas using its process.

In relation to amended claim 15, the present invention is believed to distinguish over Caldwell for the same reasons as recited for claim 14 above. Furthermore, amended claim 15 teaches oxidizing agents not disclosed by Caldwell.

Claim 16, which is dependent upon claim 14 is believed to distinguish over Caldwell for the same reasons as recited above for claim 14 above. Furthermore, claim 16 sets a range of weight ratios between the oxidizing agent and Hg. This range of weight ratios is important because it defines the optimal concentration range of the reactants and allows one to maximize efficiency by using only the amount of oxidizing agent necessary to accomplish oxidation saving both money and time. Nowhere does Caldwell suggest a range, ratio or weight percentages for the oxidizing agent. Applicants believe that the ratio disclosed in claim 16 is neither anticipated or obvious in the light of Caldwell as the disclosed weight ratio range is an improvement in the art in that it increases efficiency.

Claim 18, which is dependent upon claim 14 is believed to distinguish over Caldwell for the same reasons as recited above for claim 14 above.

Claim 19, which is dependent upon claim 14 is believed to distinguish over Caldwell for the same reasons as recited above for claim 14 above. In addition, claim 16 sets a range of weight ratios between the oxidizing agent and Hg. This range of weight ratios is important because it defines the optimal concentration range of the reactants and allows one to maximize efficiency by using only the amount of oxidizing agent necessary to accomplish oxidation saving both money and time.

#### New Claims

New independent claim 20 is believed to distinguish over Caldwell because it incorporates all the limitations of original claims 6 and 13. Nowhere, does Caldwell

teach or suggest using the disclosed compounds as the oxidizing agent. Applicants have followed examiner's instructions to rewrite claim 6 and 13 in independent form and submit that claim 20 is in allowable form.

New claim 21, which is dependent on independent claim 1 is believed to distinguish over Caldwell for the same reasons set forth for claim 1 above. Additionally, new claim 21 teaches that presence of SO<sub>x</sub> improves Hg removal. Applicants unexpectedly discovered that the presence of SO<sub>x</sub> actually improves Hg removal when the oxidizing agents disclosed in claim 1 (chloric acid, chloric acid and alkaline metal chlorate) are used. As applicants explain in the specification while sulfur dioxide typically has a detrimental effect upon oxidizing agents such as chlorine (taught by Caldwell) and bromine, the negative effects of sulfur dioxide are considerably less upon gaseous chloric acid or chlorine dioxide taught by the applicants. See pg. 10 lines 27-30 and pg. 11 table 2 of the original disclosure. This argument also applies to all the claims which teach the use of chlorine dioxide, chloric acid and alkaline metal chlorate or chloric acid as the oxidizing agent.

New claim 22, which is dependent on independent claim 1 is believed to distinguish over Caldwell for the same reasons set forth for claim 1 above. Furthermore, claim 22 discloses that the oxidizing agent converts NO to water soluble NO<sub>2</sub>. See, pg 5 lines 5-7 of the applicant's original specification. In contrast, Caldwell neither teaches or suggests that its oxidizing agent converts NO to water soluble NO<sub>2</sub>. In fact, when reacted with molecular chlorine (as taught by Caldwell) NO does not readily convert to water soluble NO<sub>2</sub>. This distinction is important because NO<sub>2</sub> is water soluble and NO is not. Therefore, NO<sub>2</sub> is much more easily removed from the gas stream using aqueous

scrubbers. This argument also applies to all the claims which teach the use of chlorine dioxide, chloric acid and alkaline metal chlorate or chloric acid as the oxidizing agent.

New claim 23, which is dependent on independent claim 7 is believed to distinguish over Caldwell for the same reasons set forth for claim 7 above. In addition, claim 7 distinguishes over Caldwell for the reasons explained for claim 1.

New claim 24, which is dependent on independent claim 7 distinguishes over Caldwell for the same reasons set forth for claim 7 above. Furthermore, new claim 24 discloses using oxidizing agents not taught or suggested by Caldwell.

New claim 25, which is dependent on independent claim 14 distinguishes over Caldwell for the same reasons set forth for claim 14 above. Furthermore, new claim 24 discloses using an oxidizing agent not taught or suggested by Caldwell.

New claim 26, which is dependent on independent claim 14 distinguishes over Caldwell for the same reasons set forth for claim 14 above. Furthermore, new claim 24 discloses using oxidizing agent not taught or suggested by Caldwell.

New claim 27, which is dependent on independent claim 14 distinguishes over Caldwell for the same reasons set forth for claim 14 above. Claim 27 also teaches the process of vaporization as passing an oxidizing solution through a heat exchanger in order create a vaporized oxidizing agent. See pg 6. of the original application. Claim 27 also defines a preferred temperature range for vaporization.

New claim 28, which is dependent on independent claim 14 distinguishes over Caldwell for the same reasons set forth for claim 14 above. Moreover, claim 28 teaches actively mixing the gaseous stream with the vaporized oxidizing agent by inserting the oxidizing agent in a counter current direction with respect to the flue gas. This distinction is important because actively mixing the oxidizing agent with the flue gas stream

reduces the residence time required for oxidation, increasing efficiency. See, pg. 6 lines 26-29 of applicant's original disclosure. Caldwell neither teaches or even suggest injecting the oxidizing agent in a counter current direction.

New claim 29, which is dependent on independent claim 14 distinguishes over Caldwell for the same reasons set forth for claim 14 above.


New claim 30, includes essentially all the limitations of original claim 2 which examiner notes are not disclosed by Caldwell. Caldwell fails to teach or even suggest using chloric acid, chlorine dioxide or chloric acid and an alkali metal chlorate as the oxidizing agent. It is believed that, claim 1, as amended, distinguishes over Caldwell.

It should be noted that many of the arguments presented for one claim ,may be, and often are, applicable to other claims.

Applicants' attorney has carefully reviewed the other references, cited by the Examiner but not applied. None of these cited references anticipated Applicants' invention as now claimed.

The Applicants believe that the application, including claims, 1,3,7,9,11,14-6, and 18-29, is now in allowable form. Allowance is therefore respectfully requested

Respectfully submitted,

  
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Date: 1/21/03